

*management
looks at
computer tape*

THE
FINANCIAL
VIEW

GINKI

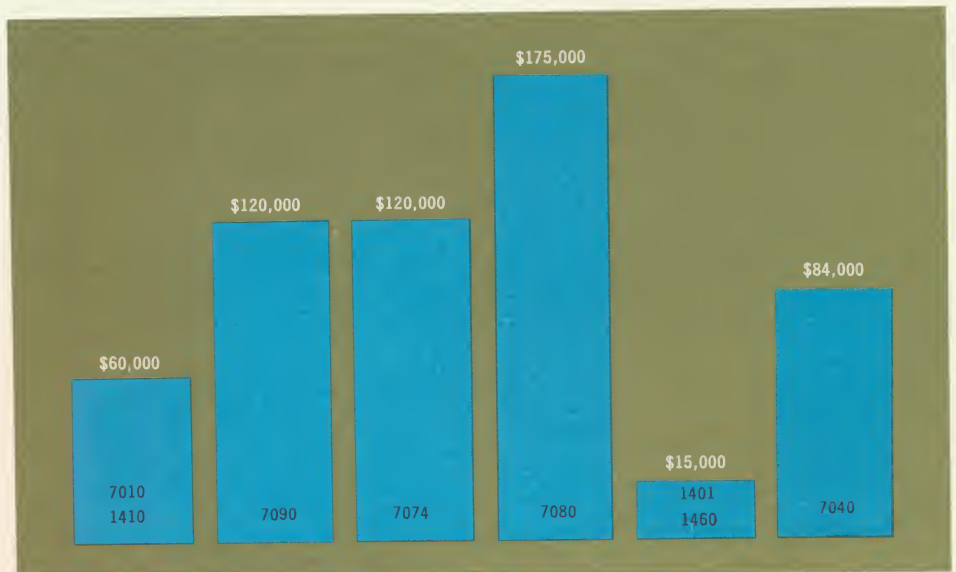
who's minding the storage?

MANAGEMENT'S INTEREST IN COMPUTER TAPE

A previous book in this series discussed a paradox in connection with the technical aspect of computer tape: Tape is one of the most vulnerable elements of the computer, and yet it is not included in the maintenance policy. It further pointed out that this is not an oversight or a breach of ethics on the part of the manufacturer. The fact is, the computer user is the logical one to provide the program of tape control and maintenance necessary to insure the optimum use of tape.

The present book discusses a related, and commonly overlooked side of the problem, the financial aspect of tape management. And it brings to light another paradox—Magnetic Tape is an extremely large part of the computer investment, and yet it is not covered by the warranty. Once again, this is not an oversight or a breach of ethics by the manufacturer. It is simply the recognition of the fact that the logical one to control and protect the tape investment is the management of the computer installation.

THE MONEY SIDE OF TAPE



*GKI survey

There are two things that management discovers when it becomes involved in automatic data processing. (1) It takes a great deal of money to acquire a computer and (2) It takes a great deal of money to keep one. Presumably the first discovery occurs before a commitment is made. Consequently, management is free to consult, compare and select in order to be certain that it is spending its money efficiently. In the second case, the commitment comes first and the discovery later. Generally, with the discovery comes the effort to develop efficient cost control. One of the obvious places to start a program of efficient cost management is the Tape Library.

The graph above shows why. It is part of a GKI study relating the size of the

library to the computer. It points out that there is a substantial investment in computer tape.

But the money side of tape extends beyond the cost of raw tape. The computer programs, the initial data and corporate records are stored on tape. This represents an investment which is more significant than the hardware. The financial management of tape extends to three levels of expenditures:

Purchasing Dollars. Dollars spent in buying new tape.

Operating Dollars. This term extends to that part of the cost of operating the computer which is attributable to magnetic tape.

Catastrophic Dollars. The cost in dollars

and good will which flaws in the final document can cause, and the cost of lost information due to damaged tape. It is the purpose of this book to present elements of the financial side of tape management—the techniques and tools for (a) protecting the investment and (b) controlling the expenditures.

The performance of tape is perhaps best understood in industries where advanced programs of value analysis have probed deeply into the cost area—and cost improvement opportunities—that previously had been completely obscured by misconceptions and lack of knowledge. This booklet draws heavily on the findings of the value analysis teams of some of the best organized computing installations in the country.

PROCUREMENT DOLLARS

the expanding library

In 1964, purchases of magnetic tape for data processing applications amounted to 63 million dollars. In the six years from 1964 to 1970, two thirds of a billion dollars will have been spent to buy new tapes. This is an increase of 10 times. True, some of these tapes will be used in new equipment, but the bulk will have been purchased for existing installations.

Assuming, very conservatively, that as much as three quarters of that amount will be used in installations not presently in existence, we are still faced with the fact that those who spent the 63 million dollars in 1964 will spend three times that amount in the following six years. Even with such an unrealistically conservative assumption it is not at all unlikely that a tape user will have an average increase of 50% per year in the size of his tape library.

The chart below shows the predicted sales of tape for data processing use

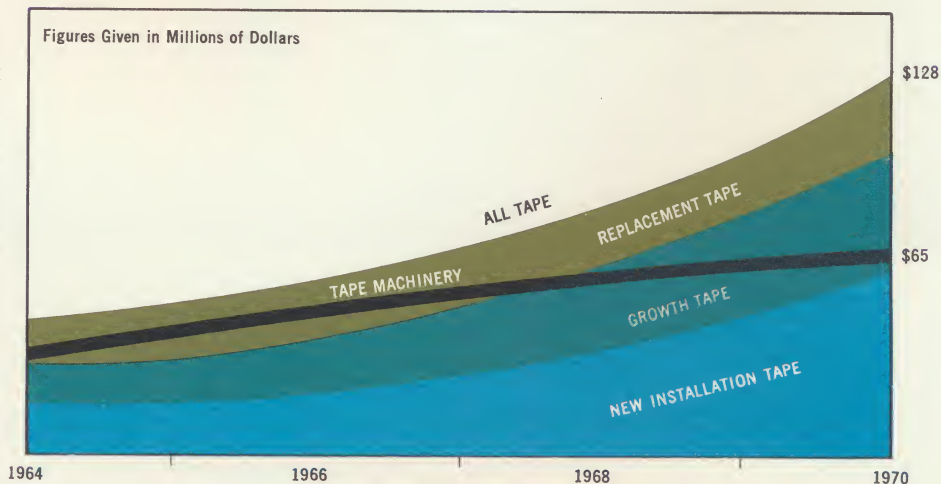
for the six year period. Some notion of the expansion of the average tape library can be obtained by comparing the rate of growth of tape expenditures with that of tape handling machinery which is also plotted on the same graph.

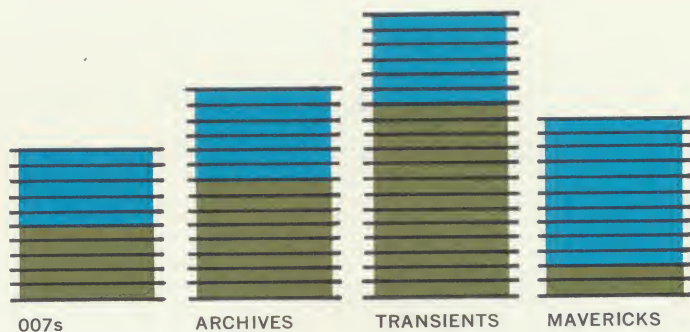
As the chart indicates, new purchases can be classified into:

Tapes for new installations.
Tapes for existing installations.

- (a) Additional tapes for the growing library.
- (b) Replacement of worn out and obsolete tapes.

The rest of this section will be devoted to a discussion of these last two types of tape purchases.





growth tape

As it gains in experience and acceptance, the computer assumes a wider role in the business of the company. Its work load increases. This means that (a) more tapes are needed and (b) computer time becomes more critical. These are signs of a healthy installation. They are also the things that increase the need for effective management.

Tape Volume. As the requirement for tape grows, the problems of procurement increase. Assurance of tape quality, for instance, becomes more critical. Magnetic Tape, as any other component which is manufactured in batches, is graded through a technique of statistical selection or quality control. The various grades are sold either as different levels of quality or as intended for less critical applications: 200 BPI, 556 BPI, 800 BPI, etc. The prices vary with the grade, and it is possible to match the tape to the transport.

Quality conscious managers have adopted the standard method of dealing with batch produced components—a policy of incoming inspection. This is the proven way to evaluate competitive brands, and to insure vendor reliability and consistent tape quality. With new instruments such as GKI's TC-3 Tape Certifier, incoming inspection systems can be established at a minimum cost and with no burden on computer time.

Uncontrolled Growth. This is probably the most aggravating problem of the expanding library. It not only causes overprocurement but creates storage difficulties as well. Measures can be taken to eliminate some forms of this problem. In every library permanently idle tapes have a way of accumulating. A periodic roundup and reemployment of these tapes can materially reduce procurement costs and storage problems. Some of the offenders are:

007s. Very often classified tapes retain

their status long after the reason for classifying them ceases to exist. De-gaussing with such equipment as the GKI K-80 will completely erase all information from the tapes and restore them to active duty.

Archives. The size of archives storage can often be reduced by consolidating short records.

Transients. Data tapes are prone to multiply rather quickly, particularly in those installations where the processing is central and the data originates in a variety of locations. There is a tendency to acquire more data tape than is necessary due to the fact that transient information for one reason or another is often kept as permanent data.

Mavericks. Every installation has its share of tapes which bear the cryptic label, "Bad Tape. Do Not Use." In most cases these tapes can be restored to duty after rehabilitation.

replacement tape

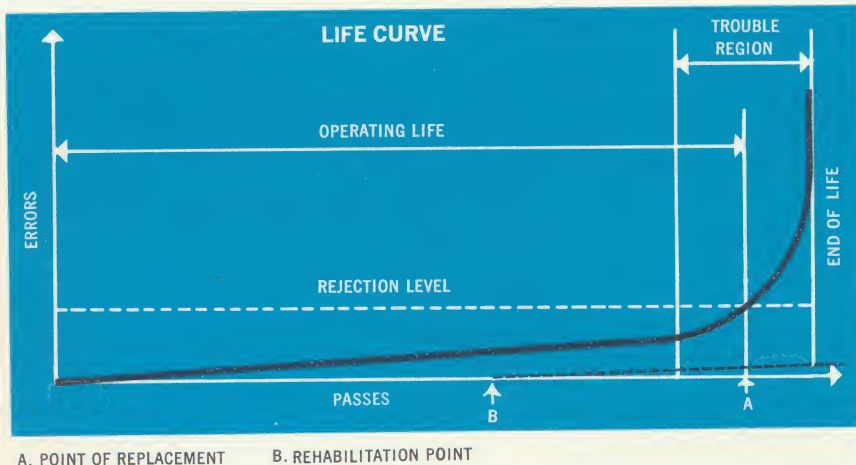
It has been pointed out that increase in library size is a sign of a healthy installation. Consequently, expenditures for additional tapes can be justified without a great deal of awkwardness. Not all procurement dollars are spent for increasing the size of the library, however. A portion of this cost is for replacing discarded tapes. Very often this expenditure escapes analysis, because the purchase of replacement tape is listed as the purchase of additional tape. The significance of the cost of replacement is thereby completely overlooked, and the notion results that replacement costs apply only to those occasional tapes that have had unfortunate operating conditions. This is fairly far removed from the facts. When the question is asked, "What tapes must be replaced?", the answer is: "All of them."

The operating life of computer tape is not infinite. Eventually, there comes a point in its history at which it must be discarded and replaced. In view of the size of the investment in tape, the prospect of replacing an entire library is bound to be a serious matter, and the analysis of the factors involved in re-

placement costs an essential element in the financial management of tape.

Rate of Replacement. The cardinal consideration in analyzing tape replacement costs is: How often should tape be replaced? Unfortunately, there is no simple determination of replacement rate. Each tape has a different history and consequently, a different life span. Some formulae have been worked out for estimating life expectancy, but they are admittedly concerned with ideal or artificial circumstances. Statistical data on the average rate of replacement is scarce because replacement costs are invariably, lumped together with purchases of additional tape. A number commonly quoted by some managers who have kept records is that 20% of the library is replaced each year. A library of 4,000 tapes can thus run into replacement costs in the neighborhood of \$20,000 per year.

This number, of course, is a generality which fixes some measure to the significance of the problem. A more useful look at the problem of replacement is shown by the Life Curve on the next page.



Although each tape has a different life expectancy, nevertheless, every tape, unless an accident intervenes, passes through the same general stages. A practical analysis of the replacement problem, then, can be derived from the Tape Life Curve. This curve expresses tape life in terms of the number of failures and the number of passes through the transport. Starting with a perfect tape, flaws will normally increase with the number of passes. Further, as the number of flaws increase so does their rate of increase. From this, certain definitions can be established.

Tape Life. Tape life can be defined as the number of passes a tape makes from its initial use until the End of Life.

End of Life. This can be defined as the point at which the tape develops enough flaws to render it useless. Two types of End of Life may be distinguished:

Absolute End of Life. Here, there are

so many flaws that the tape will not function at all.

Practical End of Life. In this case, the tape can produce usable results, but due to the trouble—both cost and annoyance—caused by failures, it is impractical to use it any longer. This leads to another consideration—Rejection Level.

Level of Rejection. Every installation has some criterion of rejection. The common technique is to declare a tape unacceptable when it produces an inordinate amount of downtime. A less subjective criterion is to establish a maximum allowable number of errors. One computer manufacturer has set 15 dropouts in the entire length of tape as the threshold of rejection.

Replacement Point. With a fixed number of errors as the rejection level, replacement time can be determined. A tape will be replaced when the number of errors exceeds the rejection level.

Significance of the Curve. Prolonging the life of the tape will reduce the replacement rate. Since the End of Tape Life is ultimately determined by the flaws which the tape develops, tape life can be prolonged by removing and preventing these flaws. A proven way to do this is through a program of tape maintenance including periodic cleaning and repair (tape rehabilitation). There is a clear economic advantage to this. Repairable tapes sent to GKI Service Center are returned in virtually new condition. This effectively doubles the life of the tape at about $\frac{1}{3}$ the cost of replacing it. If we use the figure of 20% replacement rate and a library of 4,000 tapes, the resulting reduction in replacement dollars will approach \$12,000 per year. In addition, by setting a more stringent level (say 6 errors) for determining the rehabilitation point, the Trouble Region can be by-passed. This can result in additional savings in operating dollars, and will be discussed in another section.

obsolescence

The arrival of new generation tape handlers has posed a problem for computer managers. Present equipment requires 7 tracks and 556 or 800 BPI. The new systems call for 9 tracks and densities up to 3200 FCI. The additional tracks use a greater area of the tape, and the extreme densities make stringent demands on the uniformity of the tape's surface. Consequently, tape flaws are more likely to result in errors. This raises the question: Are present tapes adequate for the new equipment?

The tests provide some clues. In test A, increasing the number of tracks from 7 to 9 increased the number of errors 265%. This is a significant amount and indicates that these tapes, in their present condition, will cause trouble. However, it is not disastrous. The almost linear relationship of the number of errors to the area used indicates that the area used is the dominant factor in the change. Cleaning this area should remove the problem. And that is what happened. After rehabilitation all but

six tapes were certified for both types of equipment.

Increasing the density is a different story. Here surface quality (smoothness) is an important factor and this is a characteristic of manufacture rather than condition. Five tapes were used, each of a different brand and in good condition for use at 800 BPI. They were tested with Total Surface Testing techniques at 800 BPI and at 3200 FCI. Three of them were unusable at 3200 FCI. Tape I, with below normal amplitude was obviously not manufactured for 3200 FCI operation. In short, 3200 FCI performance cannot be predicted or inferred from 800 BPI performance.

Tape libraries, in their present condition will not do justice to the new equipment. With proper cleaning and repair many can be certified to meet the new requirements. Others cannot. They must be replaced. In either case, the performance and longevity of tape will be even more dependent on its quality and condition.

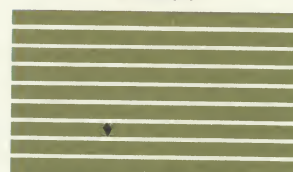
TEST A			TEST B			
ALL TAPES AT 800 BPI			ALL TAPES TOTAL SURFACE TESTED			
	7 TRACK ERRORS	9 TRACK ERRORS	800 BPI		3200 FCI	
			AMPLITUDE	ERRORS	AMPLITUDE	ERRORS
GROUP I	55	107	100%	0	72%	285
GROUP II	109	139	104%	0	101%	9
GROUP III	24	131	104%	4	103%	44
GROUP IV	54	212	104%	0	101%	16
GROUP V	60	429	101%	9	101%	185
GROUP VI	179	275				
TOTALS	489	1293				
AVE. PER TAPE	8	22				
Each group contains 10 tapes.			Amplitude levels relative to standard calibration tape. Errors at standard test levels.			

7 TRACK



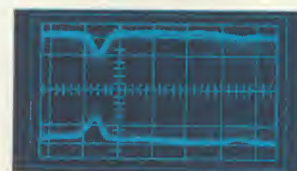
FLAW BETWEEN TRACKS

9 TRACK



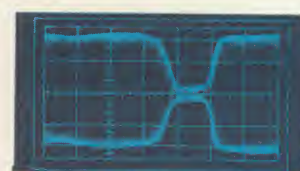
SAME FLAW CAUSES DROPOUT

FLAW AT 556 BPI



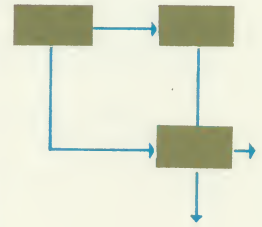
INFORMATION NOT LOST

SAME FLAW AT 3200 FCI



INFORMATION DESTROYED

OPERATING DOLLARS



computer safeguards

Tape is more than a passive but expensive receptacle for data; it is a working part of the computer. Its operations are computer operations, and its failures are computer failures. The main danger from tape failure is that incorrect data will be fed into the computer or that false results will be printed. To prevent this, the following safeguards are set up:

Mechanical. In modern tape drives, cleaning screens are used to catch loose dirt and dust which collect on the surface of the tape.

Functional. The redundant check digit is a powerful tool for detecting and identifying errors. It is a costly feature but worth the expense. Redundant programming is also standard safeguard.

Procedural. In well run installations at least two kinds of procedures are established for minimizing the effects of tape failures: (a) Checking, such as testing each tape for failures before use. And (b) Preventive, such as cleaning the transports and guides periodically during operation. These safeguards are quite effective in forestalling the generation of false data. However, they take their toll in unproductive computer time.

Unproductive Time. Offsetting the effect of faulty tape requires time—time that normally would be spent in productive computer operation. This unproductive time affects the operating cost of the computer on three levels:

Excess Machine Time. Tape failures

are usually detected by the check digits and cause the operation to be repeated until such time as the error is overcome. While this removes the danger of false data it causes the machine to take longer to do the job.

Rerun to Restore Lost Data. Whenever flaws in the tape obliterate the information, the information must be regenerated. This entails a rerun of that part of the program, and often an entire program must be rerun. It is a major source of financial loss in tape use.

Personnel Time. The time and effort spent in tracking down source material, interpreting errors and manual repair of tapes, as well as idle operator time, are considered by many users the most costly expense due to tape errors.

machine language

(with a speech impediment)

The check digit is a particularly useful device in preventing errors while transferring data. However, at each check error during a write operation the machine stops; backs the tape up and tries again. If the error persists after a specific number of attempts, the computer skips to another part of the tape. All this stuttering requires time—unproductive time—and its cost has been analyzed in a number of ways. The figures range from \$0.03 to \$0.19 in excess machine time per error. What this amounts to over a period of time, and how the condition of the tape affects this cost is shown on the chart below.

A normal day produces about 100 passes on a single tape drive. An average un-rehabilitated tape contains about 25 errors. This is somewhat over the 15 error rejection level and in the trouble region of the life curve. However, it is considerably lower than the average errors per tape received at the GKI Tape Center for rehabilitation and is far from an unrealistic assumption.

Assuming a cost of \$0.05 per error (and this is conservative) the cost in excess machine time is about \$2500 per month or \$30,000 per year. If rehabilitated tape is used (having 0 to 6 errors) the maximum cost due to tape flaws is \$600 per month or \$7,200 a year in excess machine time.

Add to this the cost of rehabilitating 20% of the library per year. For a 4,000 tape library this amounts to \$6,825—a difference of \$15,975 a year for each tape drive. From this it can be seen that cost of excess machine time due to faulty tape can be considerable unless proper maintenance is established.

WITHOUT REHABILITATION			WITH REHABILITATION PROGRAM		
AVE. ERRORS PER REEL	COST PER ERROR	EXCESS COST PER PASS	MAX. ERRORS PER REEL	COST PER ERROR	EXCESS COST PER PASS
25	\$0.05	\$1.25	6	\$0.05	\$0.30
PASSES PER DAY	EXCESS COST PER PASS	EXCESS COST PER DAY	PASSES PER DAY	EXCESS COST PER PASS	EXCESS COST PER DAY
100	\$1.25	\$125	100	\$0.30	\$30
EXCESS COST PER DAY	DAYS PER MONTH	EXCESS COST PER MONTH	EXCESS COST PER DAY	DAYS PER MONTH	EXCESS COST PER MONTH
\$125	20	\$2,500	\$30	20	\$600
REHABILITATION RATE: 20% Yearly (Assuming 4000 Tape Library.)					
NO. OF TAPES PER MONTH		COST PER TAPE	COST PER MONTH		
65		\$8.75	\$568.75		

the semi automatic computer

Tape errors discovered while writing cause only an interruption in the program. If this particular area of the tape is so bad that writing is impossible, the computer automatically skips to another tape region.

With reading, the problem is different. If the information is so obscured by tape flaws that reading is impossible, operation is halted and an attempt is made to locate and repair the trouble by hand. Failing this, it may be necessary to go back to original data to re-establish the lost record. Translating reading errors into dollars is a difficult task since there is no way of determining what kind of trouble a reading error

can produce. Some estimate of the cost of lost computer time is suggested by the chart below. It is taken from the records of a large aerospace installation and is a plot of six weeks of scheduled jobs (i.e. high priority jobs in which better tapes are used and error projections are optimistic).

Of the 50 hours running time roughly 6% was down time due to tape. This was over half the total down time, and in every case the additional down time was associated with the tape difficulties. In an 8 hour day with a \$300 per hour computer this represents roughly \$144 to \$250 per day due to tape trouble.

SUMMARY OF TAPE TROUBLE LOGS FOR SCHEDULED JOBS

A	B	C	D	E	A	B	C	D	E
1	6	172	•	•	14	7	193	•	•
2	5	60	•	•	15	1	40	•	•
3	7	187	•	•	16	6	75	•	6
4	2	66	8	8	17	9	331	•	•
5	6	193	71	37	18	4	75	•	•
6	3	39	10	10	19	2	15	•	•
7	8	82	•	•	20	2	167	230	100
8	6	54	•	•	21	12	86	•	•
9	5	51	•	•	22	8	58	•	•
10	7	220	20	20	23	2	294	15	6
11	3	59	•	•	24	3	55	•	•
12	7	272	•	•	25	2	80	•	•
13	3	75	5	5					
					Totals	126	2999	365	192

A. Day
B. No. of Jobs
C. Mins. Spent on Scheduled Jobs

D. Total No. of Mins. Lost
E. No. of Mins. Lost through Tapes

CATASTROPHIC DOLLARS

bad check passer

Probably the most important unproductive expense which tape can incur is that which affects the final document of the system. The final document can be a check, a payroll, a tax return, an engineering report or a recommendation for management decision. All these things are critical, and any failure connected with them is bound to be serious, or, at the very least, embarrassing. Generally speaking, tape failures affect the final document in three ways:

Delays. When deadlines are critical, and they usually are where computer processing is involved, a holdup due to lost information can be disastrous.

Incorrect Data. Flaws in the tape can distort the information so that incorrect data will be processed. Obviously, this type of error can be serious if the document is a check, a payroll, an engineering report or a tax return. Such errors, while scarce, can and do occur despite

the fact that the various functional safeguards are very effective in insuring the accuracy of the data that enters the computer. When they do occur—as in the case of the erroneous million dollar payroll check or stock dividend—they are usually accompanied by widespread publicity and red-faced explanations. The diagram on the right suggests a type of flaw that can go undetected by certain built-in safeguards commonly used in computers.

Lost Records. With increased use of electronic data processing, magnetic tape becomes an efficient repository of the company's records. Damage to the tape due to dirt or distortion can result in the loss of valuable corporate records—sometimes irretrievably.

The expense incurred by tape in catastrophic dollars is difficult to measure. At best it can only be estimated or described in terms of embarrassment or crises.



probabilities and the laws of large numbers

Computer manufacturers and tape manufacturers have combined their efforts to produce an extremely efficient system. Tape manufacturers have gone to extreme lengths to produce an initially perfect tape. And computer manufacturers have exerted considerable ingenuity to provide safeguards against malfunction. The result is a system in which the probability of error is very small. The computer user, in his turn, pays for all this, and there is a tendency to assume that there can be no undetected error in the final document. But it must be remembered that the tape manufacturer can only guarantee an error-free tape through one pass of the computer, and the computer manufacturer will incorporate preventive features insofar as he can control the situation. There are 160 million bits on the tape. To construct a system which reduces the chances of system error to 1 in a million is not very reassuring if every bit on the tape is susceptible to being distorted.

But even if these safeguards were 100% effective, it must be remembered that each time they are called into play, it costs money and time. To use them to offset the effects of defective tape is wasteful and defeats their purpose. Which brings us back to the original point of this booklet: The responsibility of insuring the optimum use of computer tape, both in performance and in cost, ultimately rests with the computer management. Where management has recognized this, organized programs of tape control have become standard. And in the process specialized techniques, equipment and services for handling tape problems have been developed. Computer managers have found it profitable to consult specialists in these measures in organizing their programs. The most experienced tape specialist, and the one with the most successful record is General Kinetics, Inc. GKI has solved more problems and developed more tape maintenance equipment than any independent organization in the field.

THE PROBLEMS OF WASTE

The financial necessity for establishing a realistic program of tape management is becoming more clear cut. This booklet called attention to the three important areas where waste is likely to occur. It also suggested some of the various problems that are indigenous to these areas

In the area of Procurement it distinguished between the purchase of

growth tape and the purchase of replacement tape. This distinction points up the fact that there are two aspects to reducing procurement costs, effective buying and increasing the life of the tape.

In the area of Operation, three kinds of non-productive computer time were distinguished and the ways they are aggravated by the condition of the tape. And finally, it called attention to the

fact that the misuse and misunderstanding of the purpose of certain computer safeguards can result in problems in the final document—missed deadlines, destroyed corporate records or false results.

Solutions to these problems and the hardware to implement them will be discussed in detail in the third book in this series: Improving The View.

PROCUREMENT DOLLARS	Problem: Securing 100% dropout-free tape. Solution: Establish incoming quality inspection programs using GKI certifiers.	Problem: Unnecessary Dead Storage. Solution: Rotation techniques and tape reclassification programs. GKI degausser for reuse of Special Status Tapes.	Problem: High replacement rate. Solution: Prolong life of tape through tape rehabilitation—GKI cleaner or Tape Service. Program of upgrading for obsolescent tapes.
OPERATING DOLLARS	Problem: Excessive read/write attempts. Solution: Keep tape flaws to a minimum by establishing a program of tape certification and scheduled rehabilitation of every tape.	Problem: Rerun to Restore Lost Data. Solution: Establish a program of certification and rehabilitation to prevent loss of data.	Problem: Reconstruction of Data From Original Source. Solution: Periodic Winding on GKI Tension Controlled Winder. Periodic tape certification and rehabilitation.
CATASTROPHIC DOLLARS	Problem: Missed Deadlines. Solution: Adequate scheduling. Use only certified tape.	Problem: Incorrect Data. Solution: Install comprehensive checking procedures. Use only certified tape.	Problem: Ruined Records. Solution: All Archive Tapes should be wound on GKI programmed tension, precision tape winder before being stored and periodically thereafter.

and their solution

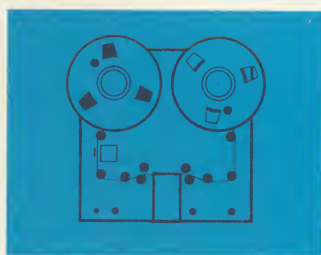
A program of tape maintenance will result in more reliable computer operation and considerable savings. GKI can help you determine the optimum program for your needs and the best implementation of it. For those who wish to evaluate tape maintenance, GKI's Tape Center is available. Tapes sent to the center are tested, cleaned, inspected, repaired, precision wound, repackaged and returned with a report of their con-

dition. The cost is modest, and the user is not committed to a large investment. For those who wish their own facility, GKI has equipment and programs for every requirement. Some of GKI's equipment is listed below.

For a discussion of a cost saving solution to any or all of your tape problems, contact the GKI office in your area.



Testers. GKI has a full range of magnetic tape testers from the low cost TC-3 Certifier to the new Model 97 Tester, a complete work station which is the industry standard for both tape manufacturers and users. It provides 7 and 9 Track as well as Total Surface Testing and handles all densities including 3200 Flux changes per inch.



Cleaners. GKI pioneered computer tape cleaning and has developed two effective systems: (1) The patented KINESONIC process used in the GKI Model CT-2 Cleaner is the optimum technique for High volume users. (2) The Model 580 Dry Cleaner, with a unique self-sharpening blade, is preferred equipment in installations of all sizes.



Winders. The high speed re-winding employed by computers develops destructive forces in the tape which act during storage and can permanently distort the tape or strip the magnetic coating from the backing. GKI's Programmed Tension Winder eliminates this danger, and also the hazards of tape edge damage due to uneven winding.



Degaussers. The GKI Model K-80 Magnetic Tape Eraser will completely degauss a reel of tape in 60 seconds. It is approved equipment for restoring special status tapes to general duty and will restore enough tapes to pay for itself in one hour's operation. The high erasure level (85 db to 105 db) also significantly reduces tape noise.



GENERAL KINETICS INC. 2611 Shirlington Road, Arlington, Virginia 22206